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AN EVALUATION OF FYKE TRAPPING AS A MEANS OF INDEXING SALMON ESCAPEMENTS IN TURBID STREAMS

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ABSTRACT

Test-fishing experiments conducted on the Kenai River in Alaska in 1957, 1958, and 1959 showed that large metal fyke traps were effective for obtaining indices of the escapement of red salmon into turbid streams. The traps also provided information about the age and size composition and rate of migration of red salmon runs of the Kenai River in those years.

The traps were evaluated as test-fishing gear by comparing the characteristics of the catch in them with the commercial catch and with the results of test gill netting and seining. Traps were fished at various locations to determine the influence on the catch of water depth and velocity and proximity to shore. The studies revealed that red salmon migrated chiefly along the bank in the turbid water of the Kenai River. This same migration pattern has been observed in clear-water streams.

The number of red salmon caught in the traps each year was used as an index of the escapement. The data show a significantly lower escapement occurred in 1959 than in 1957 and 1958.

INTRODUCTION

Increasing fishing pressure and declining salmon runs in the Cook Inlet district in western Alaska have made critical the need for precise estimates of the escapement of red salmon, *Oncorhynchus nerka*, into streams of the area. Estimates of the numbers of salmon that spawn are needed to evaluate the effectiveness of salmon management regulations and to provide a basis for predicting the size of future runs.

In the research reported in this paper, large metal fyke nets were tested as a tool for obtaining indices of the escapement in extremely turbid streams, which are common to the area. In the course of conducting

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experiments with the traps, information was acquired about the age and size composition and timing of red salmon runs to the Kenai River in 1957, 1958, and 1959.

Cook Inlet salmon runs are regulated on the basis of the size of the commercial pack, the catch per unit of effort, and visual surveys of spawning fish. Counting salmon in most Cook Inlet streams is particularly difficult because the water is of glacial origin and extremely turbid. Therefore, the usual tools for counting, such as weirs, counting towers, or aircraft, are not practical.

In recent years, an index of the escapement of red salmon has been obtained by counting the spawners in a few clear-water (relatively low turbidity) tributaries of the large glacial rivers. The proportion of the total run that spawns in these tributaries is unknown, however, and may vary from year to year. Also, the time lag while the salmon travel through the various river and lake systems to the clear-water areas precludes making adjustments in the fishery to allow increased harvest, or escapement.

Test fishing offers promise as a method of determining the escapement in turbid water by providing information about the relative numbers of salmon in a river from day to day. When supplemented with marking and recovery experiments test-fishing data can also provide a basis for estimating total escapement.

Large metal fyke traps have been successfully used as test-fishing gear in Oregon and in California. The California Department of Fish and Game initiated the use of fyke traps in 1951 on the Sacramento River, which is turbid most of the year, and were successful in capturing steelhead trout *(Salmo gairdneri)*, and king salmon *(O. tshawytscha)*, and coho salmon *(O. kisutch)*. Occasionally stray red salmon, pink salmon, and chum salmon *(O. keta)*, were also taken (Hallock, Fry, and LaFaunce, 1957[3]).

[3]Richard J. Hallock, D. H. Fry, Jr., and D. A. LaFaunce. The use of wire fyke traps to estimate the runs of adult salmon and steelhead in the Sacramento River. California Fish and Game, vol. 43, no. 4, 1957, p 271-298.

Since this gear was effective in catching salmon in turbid waters of Oregon and California, we selected it for test-fishing experiments on the Kenai River, a typical glacial stream of the Cook Inlet area.

The objectives of these experiments, which were conducted in 1957, 1958, and 1959, were:

1. Evaluate fyke traps as a test-fishing device in glacial streams.

2. Obtain daily and annual indices of the escapement of red salmon into the Kenai River.

3. Determine by tagging experiments rates of movement and spawning ground destinations within the Kenai River system.

4. Identify characteristics of the Kenai River red salmon runs including timing, sex, and age composition.

EXPERIMENTAL PROCEDURE

In general the studies on the Kenai River were conducted as follows:

1. Large metal fyke traps were installed in the river and were fished continuously during the red salmon migration.

2. Traps were emptied daily to learn the relative size of the escapement.

3. Traps were fished at various locations and depths to learn the migration habits of the fish within the river.

4. Salmon taken in the traps were measured, their sex was determined, and a few scales were removed for age determination.

5. The fish were then tagged and released.

6. Seines and gill nets were fished in a standardized manner to compare this gear with fyke traps as test-fishing devices and to obtain additional fish to tag.

7. Intensive stream surveys were conducted in 1957 to recover tagged fish and to fix the time of their arrival on the spawning grounds.

8. The numbers of red salmon caught each fishing period in the commercial fishery adjacent to the mouth of the river were recorded for comparison with the numbers caught in the fyke traps.

Description of Test-Fishing Sites

The initial test-fishing site, which was located about 11 miles upriver from the mouth, was maintained all 3 years and is referred to as the index trap site (fig. 1). The main factors considered in choosing this site were:

1. Salmon were expected to migrate through the area.

2. The site was adapted to the mechanical operation of the traps.

3. Traps could be located above the influence of mean high tides, but as close to the commercial fishery as possible.

4. Equipment and supplies could be transported easily because the site was close to a highway.

At the index site, two traps were fished close to the shore in the same place all 3 years to provide indices of the daily and the total escapements. In 1958 two additional traps were fished 25 and 40 feet offshore to provide data for comparison with the traps fished close to shore.

The river at the index site was approximately 300 feet wide and flowed straight for one-fourth mile. The river banks in this area ranged from high, steep bluffs to low, flat, nearly submerged land. The water depths varied from 4 to 9-1/2 feet at individual trap locations, and the water level was affected by runoff and extreme high tides. The mean current velocity was 4 feet per second, with a range of 1.79 to 8.80 feet per second. The turbidity, as measured by a Secchi disk, ranged from 3.0 to 12.0 inches, with a mean of 8.3 inches.

In 1959 four traps were installed at a site 18 miles upstream from the index trap site to recover tagged fish and to provide estimates of migration rates and additional indices of the magnitude of the escapement. This is referred to as the upstream trap site.

Description of Fyke Traps

The fyke traps used were cylindrical and were 18 feet long and 10 feet in diameter.

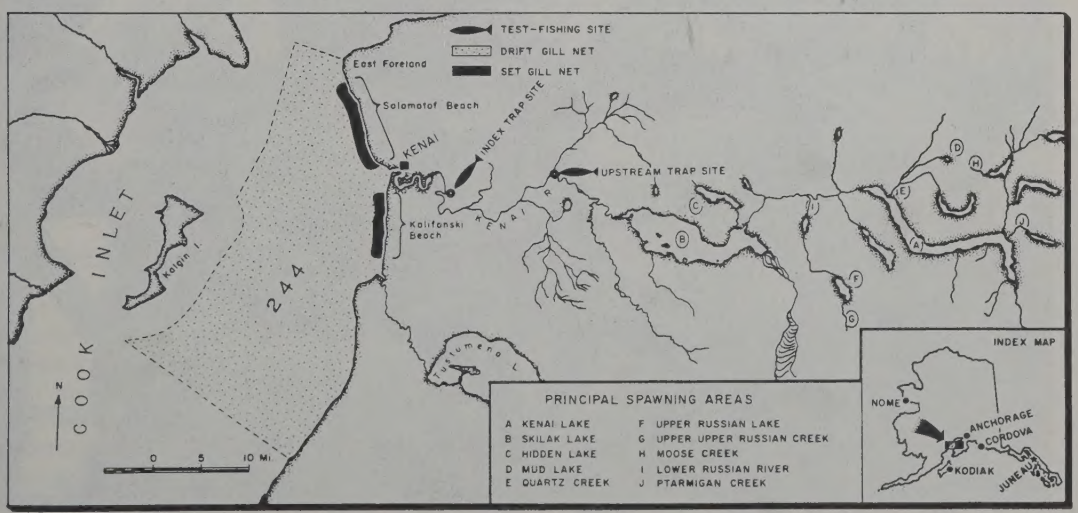

Figure 1.--Commercial fishing area, test-fishing sites, and principal red salmon spawning areas of the Kenai River system.

The frame consisted of five hoops of 3/4-inch galvanized pipe, each having a larger external hoop welded to it for a rolling surface (fig. 2). Six 2- by 1- by 1/8-inch channel iron stringers were welded to the hoops. This framework was covered with nonclimable fencing made of 2-inch square 14-gauge mesh wire. The trap was divided into two compartments by a funnel located at the midpoint of the trap. This funnel had a 26-inch opening. Another funnel with a 45-inch opening was located at the entrance to the trap. The last compartment had three equally spaced access doors so that the trap could be emptied regardless of its position on a streambank. The traps weighed approximately 750 pounds and were painted with a dark green, rust preventive, dull-finish paint. A bridle of 1/4-inch galvanized wire cable with a swivel attachment was located on the bow end of the trap. From this a 1/4-inch wire cable was stretched to shore and made fast to a tree or other good anchor to hold the trap in place against the current and debris.

Method of Fishing Fyke Traps

The traps were emptied twice daily in 1957 and 1958 and daily in 1959. Frequent checks were made each day during the height of the migration to guard against possible overcrowding of fish.

Traps were rolled out of the water by means of a 1/4-inch wire cable and a hand winch (fig. 3). The cable, which was wrapped around the trap about three turns, wound off the trap as it was brought in and wound back

Figure 2.--Metal fyke trap used in test-fishing experiments in the Kenai River.

Figure 3.--Hand winch used to roll fyke traps out of river.

on the trap when it was returned to its fishing position. A push was usually all that was required to start the fyke trap rolling down the river bank to its fishing position. Where the slope was gentle it was necessary to pull the trap into position with a skiff and outboard motor. Traps were always fished in water deep enough to cover the entrance tunnels.

To insure that they would fish in a comparable manner at all times, traps were brushed daily and thoroughly cleaned weekly with the aid of a high-pressure jet of water. Debris tended to accumulate and restrict the waterflow through the trap. During high water a constant watch had to be maintained to prevent major damage to the traps from large logs floating downstream. When water velocities exceeded 6 feet per second, mortalities of fish increased markedly.

Method of Sampling Fish

With a dip net fish were removed through one of three access doors and placed in a cradle where they were measured and tagged. The number of each species of fish was recorded at each lift. The method of sampling the trap catch for age and size composition varied from year to year. In 1957 all red salmon were measured, and a scale sample was taken from each, except during the peak of the run when only every 10th fish was sampled. In 1958 and 1959 scale samples and length measurements were taken weekly from 100 fish of each sex. Each fish was measured from mideye to fork of tail, the measurement being read to the nearest 5 mm. A scale was removed with a forceps from the fish in an area about three rows above the lateral line and on a vertical line from the origin of the dorsal fin.

Method of Test Fishing with Gill Nets

In 1957 gill nets were fished daily at the index trap site to evaluate them as a method of test fishing and to secure data on abundance, size, age, and sex composition for comparison with similar data from fyke trap catches. From June 1 to 20, a linen gill net with 5 1/2-inch mesh was used for exploratory fishing that was conducted to teach personnel how to handle the gear in swift water and to improve techniques in releasing and tagging captured salmon. On June 28 when fish appeared in sufficient numbers, fishing was resumed with a 50-foot experimental nylon gill net, consisting of five panels of graduated mesh sizes ranging from 4 to 6 inches stretched measure. The net was fished daily in a standardized manner in two areas near the index traps.

CHARACTERISTICS OF KENAI RIVER RED SALMON MIGRATION AS REVEALED BY FYKE TRAPS

In the course of the experiments to evaluate the effectiveness of fyke traps as a means of determining the size of escapements, much was learned about characteristics of the Kenai River red salmon run which is of use in management of the fishery. This information is detailed in the following sections.

Daily and Total Catches in Traps and Timing of the Migration

All five species of Pacific salmon were taken in fyke traps, with red salmon predominating each year (table 1). Dolly Varden *(Salvelinus malma)* were commonly taken also.

The total numbers of red salmon taken each year in traps 1 and 2 provide a measure of the relative size of the escapement, since these two traps were fished in the same location throughout the study. It is assumed that the trapping efficiency remained the same each year and that the salmon did not change their migration path in the river. No changes in stream topography were observed at the fishing sites during the study.

The total numbers of red salmon in index traps 1 and 2 in 1957, 1958, and 1959 were 1,934, 1,856, and 1,452 respectively. These figures are not directly comparable since the lengths of time fished each year were not the same.

In June there is an early run of red salmon in the Kenai River, but it is small in comparison with the later migration. Most of the early run enters the Kenai River before the commercial fishing season begins and therefore does not contribute to the catch. In 1957 and 1958 fyke traps were fished during June, and it was demonstrated through the recovery of tagged fish that the early run was almost exclusively bound for the Russian River, which is a large clear-water tributary of the Kenai River. In 1959 test fishing did not begin until July 1.

The numbers of red salmon taken in each of the 3 years adjusted to include the time period of July 1 through August 10, are 1,726, 1,724, and 1,309. Judging from fyke trap catches, the escapement of red salmon into the Kenai River in 1959 was only three-fourths as large as in 1957 and 1958.

Although the catch of red salmon in the fyke traps began to increase during the first week of July, the peak of the migration came at a different time each year (fig. 4).

Such variation in the timing of the run must be considered in applying results of the test

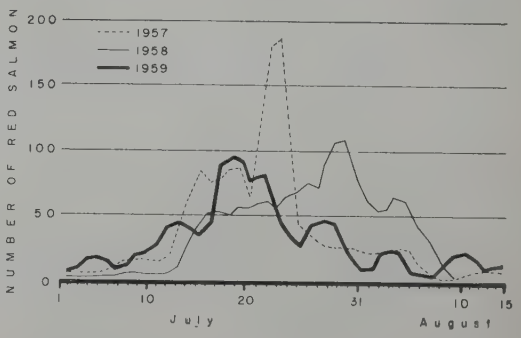

Figure 4.--Comparison of the daily catch of red salmon in fyke traps 1 and 2 in the Kenai River for the years 1957-59 (data smoothed by 3-day intervals).

Table 1.--Total fyke trap salmon catch by species at index site, Kenai River, 1957-58 (traps 3 and 4 fished only in 1958)

[Numbers of fish]

Species and year	Trap 1	Trap 2	Trap 3	Trap 4	Total
Red salmon					
1957	1,158	776	--	--	1,934
1958	748	1,108	155	220	2,231
1959	590	862	--	--	1,452
King salmon					
1957	30	30	--	--	60
1958	52	111	34	6	203
1959	26	55	--	--	81
Coho salmon					
1957	54	30	--	--	84
1958	193	116	1	15	325
1959	94	30	--	--	124
Pink salmon					
1957	25	27	--	--	52
1958	612	1,862	3	91	2,568
1959	19	81	--	--	100
Chum salmon					
1957	1	2	--	--	3
1958	0	2	0	1	3
1959	0	1	--	--	1
Dolly Varden					
1957	76	66	--	--	142
1958	44	120	6	14	184
1959	76	134	--	--	210

fishing to fishery management. It can be misleading to assess the escapement of red salmon from the trends of daily catches at the fyke traps. For example, if the trends of the catches in 1957 and 1958 during the periods July 15 to July 25 are compared, one would assume that the escapement was much less in 1958. Actually, the total trap catches for the 2 years were nearly the same, the 1958 migration extending over a much longer time.

Migration Paths and Rate of Movement

The results of fishing four traps in various locations in 1958 suggest that in turbid water

red salmon migrate along the banks during daylight hours. Similar behavior has been observed in clear-water streams elsewhere. In 1958 when the two traps were fished from 25 to 40 feet offshore (fig. 5), the catch in these traps was only one-fifth as great as the catch in the two traps that were fished close to the bank.

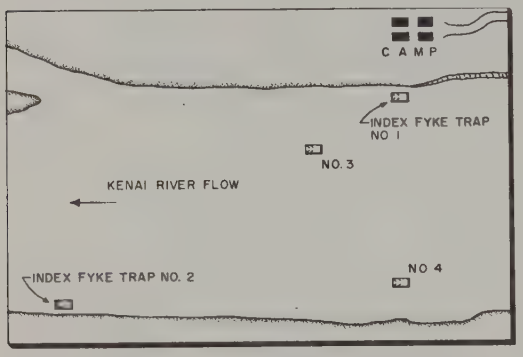

Figure 5.--Position of four fyke traps fished in the Kenai River. (Traps 3 and 4 fished only in 1958.)

Midstream island trap locations did not prove to be productive either, further indicating that the salmon migrated close to the river's edge. In 1959 two traps at the upstream site were fished at an island near midstream, but the catch of red salmon was so poor that the traps were moved to the main bank of the river.

Information was obtained in our studies about the diurnal movements of red salmon in the Kenai River. Traps were emptied at 6 p.m. and 6 a.m. each day in one series of experiments at the index site in 1958. The period 6 p.m. to 6 a.m. included a varying amount of daylight hours during the summer, and thus the two periods are not distinctly daylight and darkness (fig. 6). Fyke traps must be operated during darkness if an unbiased estimate of the magnitude of the run is to be obtained.

Kenai red salmon mill about for some time in the mouth of the river. Fish tagged at the mouth in 1958 were recovered from Kalifonski Beach and Salamatof Beach in the commercial fishery, and one tagged fish was recovered in the Kasilof River (fig. 1) by a sport fisherman.

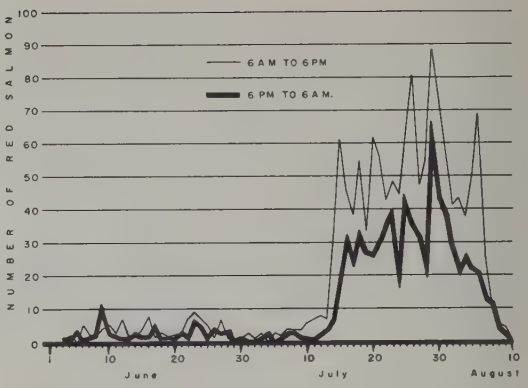

Figure 6.--Catch of red salmon in fyke traps during the periods from 6 p.m. to 6 a.m. and from 6 a.m. to 6 p.m., 1958.

This back-and-forth movement of red salmon was evident as far upriver as the index trap site, 11 miles from the mouth. All red salmon taken at the fyke traps in 1957 were tagged. Twenty-one of these were returned from the commercial fishery of Cook Inlet. One tagged fish, which was identified by the color combination of the tag parts, was sighted in Fish Creek in the upper part of the Inlet. The behavior of these fish may have been affected by the tagging and may not reflect the general movement of the fish.

Stream surveys were made frequently in 1957 on all clear-water areas of the Kenai drainage to search for the tagged fish on their spawning grounds. Most tag recoveries were made by the intensive sport fishery that operates at the mouth of the Russian River. Thus, number of days between tagging and subsequent recapture of tagged fish is one measure of their rate of travel.

There was considerable variation in length of time between tagging and recovery (table 2), but, on the average, red salmon traveled the 65 miles between sites in about 20 days. This is maximum travel time since the fish may have remained in the stream at the recapture site for an unknown period of time before being recovered. Also, physiological effects of tagging and handling may have been responsible for the fishes remaining at the

Table 2. --Travel time of red salmon from tagging site to recovery at mouth of Russian River, 1957

Dates	Range of days out	Average days out	Number of tags observed
June 1 - July 10	8 - 47	19.4	23
July 11 - July 25	3 - 46	21.8	70
July 26 - Aug. 10	14 - 30	20.5	13

tagging site or for moving more slowly than normal.

The dates on which the peak of the migration occurred at two well-separated trapping sites provide another measure of the rate that red salmon travel in the river. In 1959 two fyke traps were fished at a location 18 miles upstream from the index trap site. When the graphs of catches for the two stations are shifted 12 days they almost coincide (fig. 7), indicating a migration rate of 1.5 miles per day. The faster rate of travel between the index site and Russian River as compared with the rate between the index site and the upstream site may reflect the approaching sexual maturity of early-run Russian River fish.

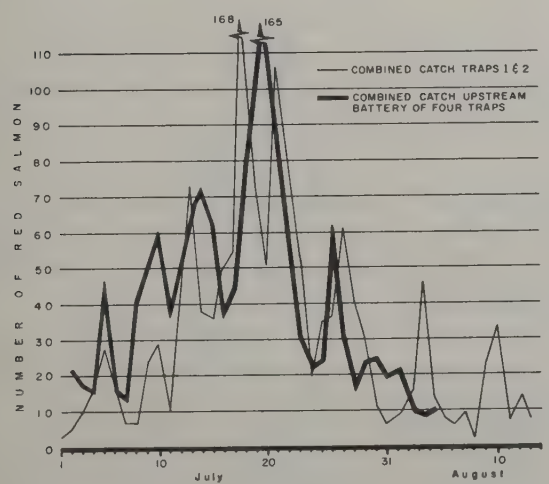

Figure 7.--Comparison of the catch of red salmon at index trap site with the catch in traps 18 miles upstream. (Upstream catch shifted 12 days to adjust for salmon travel time between sites.)

Spawning Ground Destinations

The tagging experiments each year provide information about the destination of red salmon passing the trapping site.

In 1959 stream surveys were conducted on all known clear-water spawning grounds to recover tagged fish (table 3). The streams were visited frequently to pinpoint the time of arrival on the spawning grounds.

In 1958 and 1959, tags were recovered chiefly by fishing additional fyke traps at upstream sites, and stream surveys were not as thorough as in 1957.

The first salmon to enter the Kenai River passed the trap site in June and were destined principally for the Russian River. However, fish that were tagged during the height of the run (July 10 through July 30) were recovered on spawning grounds in all major tributaries.

The tag recoveries are misleading in that recovery effort was not equal in all parts of the Kenai River system. The Russian River is a clear-water stream and has an intensive sport fishery. The other tributaries have clear portions, but there are extensive areas of the Kenai River system such as Skilak Lake that are very turbid and for which little information about salmon spawning activity is available. One might assume from the tag

Table 3.--Area of recovery and number of tags recovered from red salmon tagged in 1957

Tagging dates	Number salmon tagged	Number tags recovered												
		Soldotna Creek	Hidden Creek	Kenai River	Jean Creek	Lower Russian River	Upper Russian River	Mud Lake	Quartz Creek	Crescent Creek	Moose Creek	Trail River Creek	Commercial catch	Total
June 1-5														
6-10	28					4	1						2	7
11-15	38					3	2						1	6
16-20	53			1		4	4							9
21-25	18						2							2
26-30	42					6	2				1		2	11
July 1-5	36			1		3	2	1		1				8
6-10	103					4	1				1		1	7
11-15	391		1	3		15	1	2	1		7	2	2	34
16-20	504			5		21	2	1	3		2		1	35
21-25	714	3			1	42		1			3		6	56
26-30	187			1		9						1	3	14
31- 4	120			1		5							1	7
Aug. 4-9	43													
10-15	48		1										2	3
Total	2,325	3	2	12	1	116	17	5	4	1	14	3	21	199

recovery data that there was no spawning in Skilak Lake or its small tributaries. Actually, it is impossible to see tagged fish in the lake, and the amount of spawning there is unknown.

Seasonal Changes in Size and Age Composition and Sex Ratio

There were seasonal changes in the size and age composition, and in the sex ratio of red salmon taken in fyke traps at the index site. These changes were probably in part natural characteristics of the runs, but they also reflected effects of the intensive gill net fishery in Cook Inlet.

The gill net fishery was not active during the time the early run of red salmon passed through the Inlet and entered the Kenai River. Thus, in 1957 the fish taken in the fyke traps between June 6 and July 7 apparently had not been subjected to the selective action of a gill net fishery and were larger than fish taken later in the migration (figs. 8 and 9). This tendency toward a decrease in average size during the season did not appear to be as pronounced in the 1958 and 1959 catches.

Also, there was a difference in the average size of fish taken in the traps between years. Both male and female fish were progressively smaller in successive years. This decrease in size is understandable when the age composition of the run is considered for each year (fig. 10). In 1958 and 1959 there were

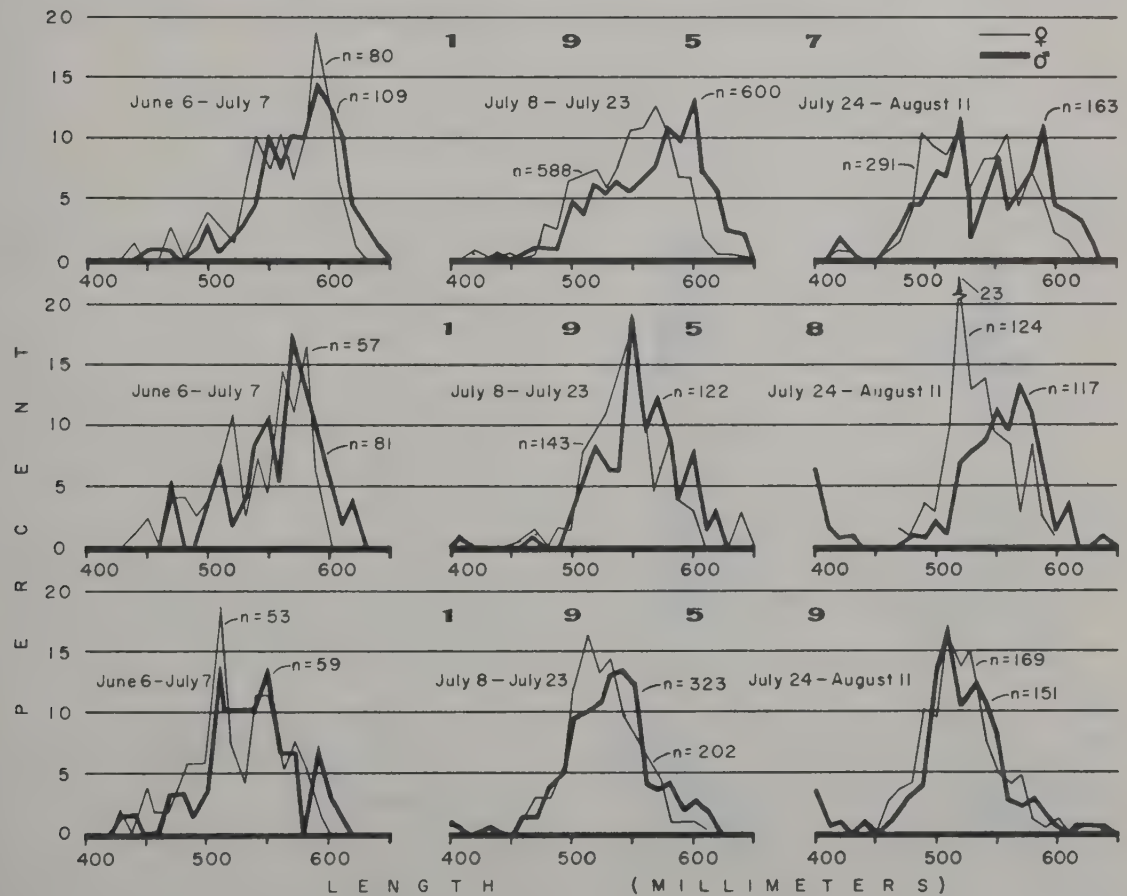

Figure 8.--Size composition of male and female red salmon taken in fyke traps in the Kenai River during migrations, 1957-59.

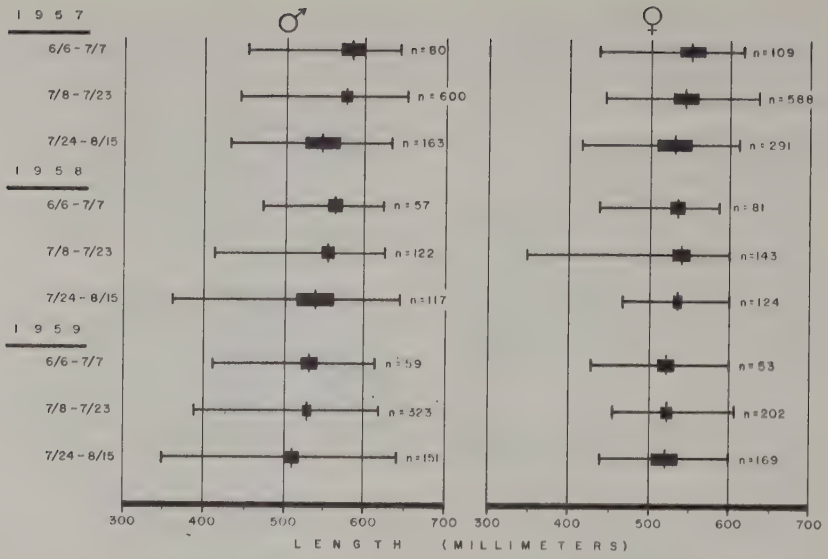

Figure 9.--Length of red salmon taken at various periods for 3 years. The range of measurements is indicated by the length of the horizontal lines; the means, by the vertical lines, and two times the standard error of the means, by the solid bar.

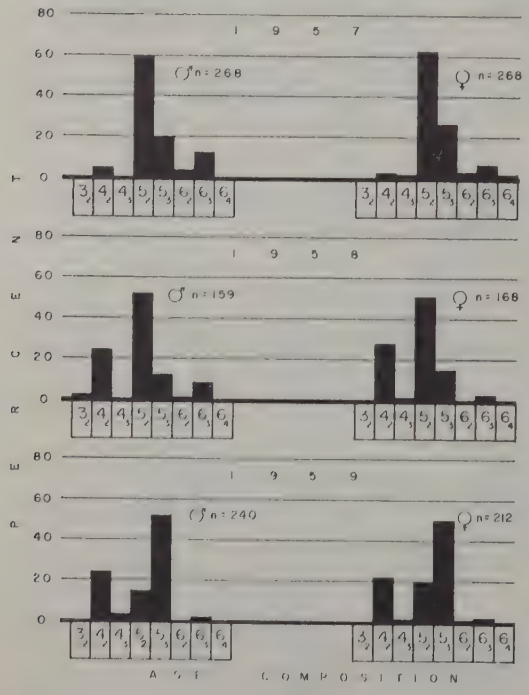

Figure 10.--Age composition of red salmon captured in index fyke traps, 1957-59.

more age group 4_2 and 5_3 (2 years in the ocean) fish than in 1957.[4] Also, age group dominance shifted from 5_2 in 1957 and 1958 to 5_3 in 1959.

The sex composition also changed seasonally and varied from year to year (table 4). In 1957 and 1959 the early part of the run included more males than females. After July 20 the reverse was true. In the 1958 study, females were more abundant in the fyke traps throughout the migration.

We can merely speculate whether these changes were true of the entire population or were the effects of gear selection. The commercial fishery was not sampled for comparison.

EVALUATION OF FYKE TRAPS AS TEST-FISHING GEAR

The usefulness of fyke traps as a means of indexing and defining the characteristics of

[4] In the age designation 4_2, the first number refers to the total age of the fish from time of spawning. The second number, written as a subscript, indicates the year of life in which the fish migrated to sea, again beginning with spawning.

Table 4.--Sex composition of red salmon captured in index fyke traps in Kenai River, 1957-59

Date	1957		1958		1959	
	Male	Female	Male	Female	Male	Female
June 1 - 7	5	1	2	6	-	-
8 - 14	26	23	8	24	-	-
15 - 21	24	11	14	15	-	-
22 - 28	11	16	26	25	-	-
29 - 5	46	19	8	10	44	27
July 6 - 12	55	51	12	29	76	39
13 - 19	307	270	132	164	258	192
20 - 26	332	400	218	256	156	176
27 - 2	67	115	262	337	74	91
Aug. 3 -9	31	55	130	156	39	50
10 - 16	18	29	-	-	44	40
Total	922	990	812	1,022	691	615

the escapement is limited unless it can be shown that the samples taken in the traps are representative of the run passing the fishing site; that is, do the traps catch fish in relation to their abundance in the river, and do they provide an unbiased estimate of the size, age composition, and sex ratio of the run?

Several findings in these studies show that fyke traps do catch red salmon in relation to the numbers present: (1) The timing, duration, and magnitude of the Cook Inlet run as indicated by commercial catches were similarly portrayed by fyke trap catches; (2) the numbers of fish caught and the composition of the catch were comparable in fyke traps fished in several locations; and (3) the catch in experimental gill nets fluctuated in a manner similar to the catch in fyke traps.

Comparison of Commercial Catch with Fyke Trap Catches

The commercial fishery of the Cook Inlet district is one of the most complex in Alaska. It employs four methods of capturing salmon: (1) the trap, which was discontinued in 1959, (2) the beach seine, which is used mainly on pink and chum salmon in the clear-water areas of the lower inlet, (3) the drift gill net, and (4) the set gill net.

Salmon run a gauntlet of drift gill nets in the open waters of the inlet and then are subjected to an intensive set net fishery along the beaches. The catch peaks first in the drift net fishery about July 17, and then about 1 week later, as the salmon approach the shore, the set net catch increases sharply.

The Cook Inlet district is divided into statistical areas, and salmon captured in the commercial fishery are reported by these areas. Area 244 includes two major set net beaches, one on each side of the mouth of the Kenai River, and a drift net area offshore (fig. 1). Area 244 was selected for comparison with the fyke trap study because this section of the inlet is most likely to contain Kenai River red salmon. The commercial catch figures reported in this study are total numbers of salmon landed from statistical area 244 during 1 week.

The timing and duration of the run as shown by the commercial set net catches were reflected in general by the fyke trap catches. Also, the curve of abundance as measured by the traps has the same general shape as the commercial catch curve, even though the numbers of fish in the river were affected by removals by the fishery (fig. 11). In 1959, in contracts to previous years, gill net fishing was permitted 6 days per week after July 19.

The fluctuations of the fyke trap catch curve in relation to the commercial catch curve and the timing and duration of the two suggest that the fyke traps sample red salmon in the Kenai River in proportion to the salmon abundance. More detailed marking experiments are needed to determine actual numbers in the escapement.

Comparison of Catches in Fyke Traps in Different Locations

The numbers of fish caught at each trap location were well correlated. For example, in 1957 the coefficient of correlation between index traps 1 and 2 was r= 0.93. The correlations between the four traps which were fished at the index site in 1958 in an array across the river were as follows:

Trap number	Coefficient of correlation, r, for traps--			
	1	2	3	4
1		.87	.83	.88
2			.70	.91
3				.76

The fact that the daily catches at the various sites fluctuated in a like manner and were consistent in this pattern, not only intraseasonally but also from year to year (traps 1 and 2), strongly indicated that the catches must be closely associated with numbers of fish in the river.

In the 1959 studies the trend and daily fluctuations of the catch at two widely separated batteries of traps, when adjusted for travel time lag, were remarkably alike. Traps apparently catch fish in proportion to the

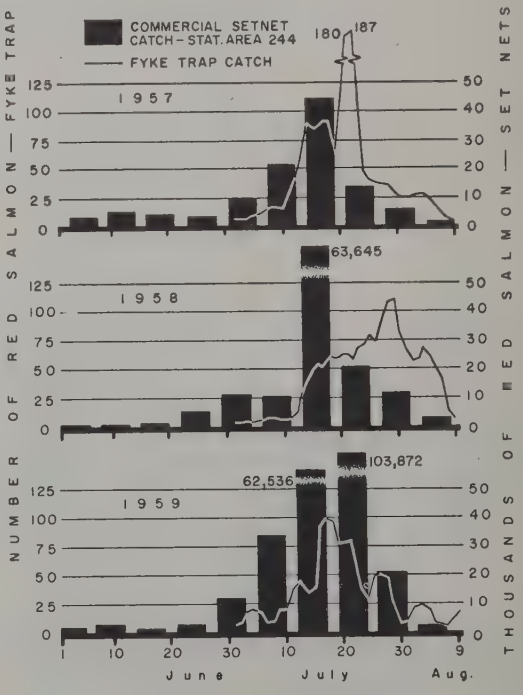

Figure 11.--Timing and duration of the Kenai River red salmon migration as measured by the commercial fishery in statistical area 244 and by fyke traps (data smoothed by 3-day intervals).

abundance, or there is a similar bias operating at all traps. The latter is unlikely, considering the wide variety of trapping sites and conditions under which traps were fished.

Comparison of Experimental Gill Net and Fyke Trap Catches

Test fishing with gill nets adjacent to fyke trap sites in 1957 showed the same timing and duration of the migration that the trap catches did. The gill net catches were small (one 50-foot net was used), but the effort was constant each day, and as shown in figure 12, the gill net catches fluctuated with the fyke trap catches, except in the late part of the migration. One possible explanation of the poor correlation then is that the gill nets selected somewhat larger fish than the fyke traps (fig. 13). Also, during the latter part of the migration the numbers of fish present were probably so few that the catches in the gill nets were not significant. When the effect of gill net selectivity is combined with the presence of smaller fish (fish that had spent only 2 years at sea) late in migration, the result is an apparent decline in the numbers of fish taken in the gill nets relative to the trap catch.

Selectivity of Fyke Traps for Size

Hallock, Fry, and LaFaunce (1957; see footnote 3) found that fyke traps did not capture king salmon as effectively as they caught steelhead trout. In experiments on the Sacramento River, traps captured from 10 to 20 percent of the steelhead trout run each year, but only about 1 percent of the king salmon run. Their studies revealed that traps were selective for small king salmon. King salmon measured on the spawning grounds and at counting stations were larger than those taken in traps.

Only a little information was gained in the Kenai River work about the selectivity of fyke traps in extremely turbid water. The results for king salmon are inconclusive, since relatively few king salmon ascend the river. In 1957 and 1959 traps did not appear to be

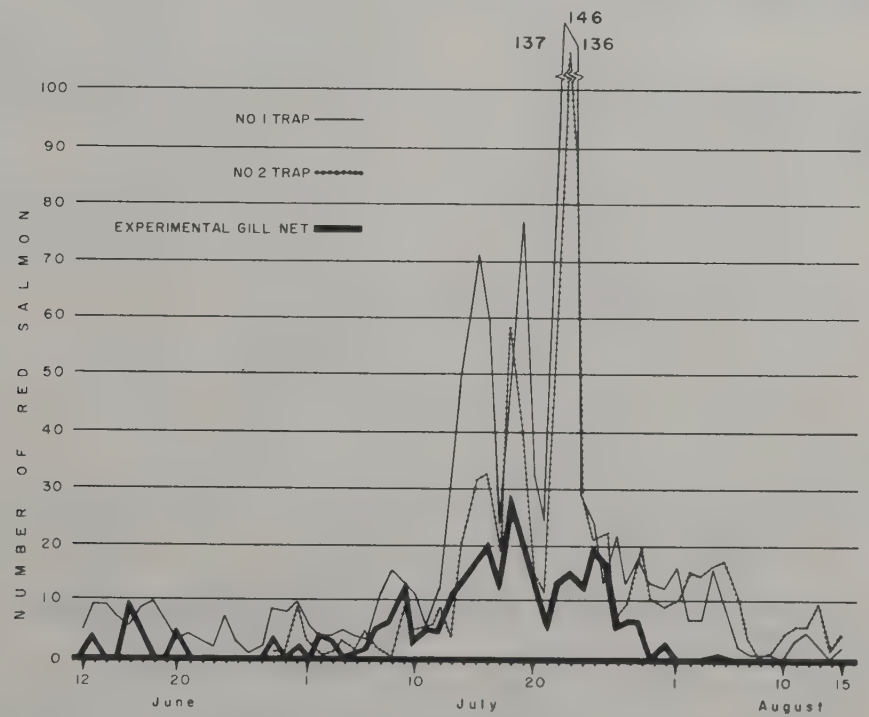

Figure 12.--Daily catch of red salmon in index fyke traps and experimental gill nets in the Kenai River in 1957.

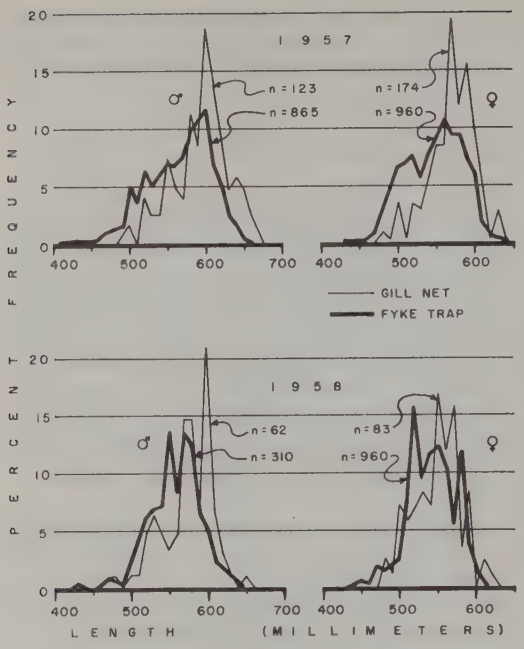

Figure 13.--Size composition of red salmon taken in gill nets and fyke traps in the Kenai River.

capturing predominantly small fish. The length of king salmon taken in 1957 ranged from 300 to 1,300 mm. Although king salmon over 1,300 mm. were captured in the traps and in the gill nets, they were not measured accurately, because every effort was made to release these large vigorous fish unharmed. In 1958, however, the trap did catch a large number of small king salmon "jacks" (a term commonly used to designate precociously developed small salmon, usually males).

There are only scattered bits of information on size selectivity of fyke traps for red salmon. Efforts to capture adequate samples of red salmon with a seine for comparison with trap-caught fish were largely unsuccessful. A limited sample taken at the upper end of Skilak Lake in 1959 by beach seine is of interest however. Daily hauls were made at the upper end of the lake to determine the size and age composition of the red salmon run and to recover tagged fish. The seining was never very productive, but the combined catch of all hauls does provide another indication of the characteristics of the run. (fig. 14). The periods selected for this analysis represent the most probable times that particular groups of fish passed the fyke trap site and subsequently passed the seining site. The range of lengths and the average size were approximately the same for fish measured

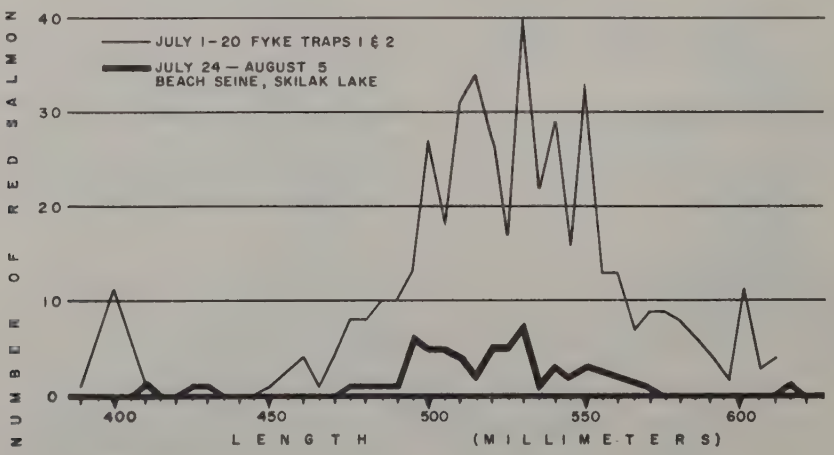

Figure 14.--Comparison of length (mideye to fork of tail) of red salmon captured in two types of gear, 1959.

at each site, which indicates that fyke traps sampled the population (as corroborated by the beach seine sample) nonselectively.

CONCLUSIONS

1. The fyke trap is a useful tool for assessing the escapement of red salmon in turbid Alaska streams.

2. There is strong evidence that fyke traps catch red salmon directly in proportion to their abundance in the river.

3. An index of the relative size of the escapement from year to year and its relation to the commercial catch can be determined.

4. The quality of the escapement, i.e., the size and age composition and sex ratios, can be adequately sampled with fyke traps.

5. The number of red salmon entering the Kenai River to spawn was considerably less in 1959 than in 1957 and 1958.

6. Red salmon migrating upstream in turbid water have the same behavior trait of following the river bank that has been observed in red salmon in clear water.

7. The red salmon migration into the Kenai River extends over a period of nearly 3 months. The early segment of the run, which passes the test-fishing site in June, is destined for the Russian River.

8. The fyke trap does not appear to fish selectively for particular size red salmon in very turbid waters.

9. The choice of location of the fyke trap is important in assuring that substantial numbers of red salmon will be taken, but regardless of where they are fished fyke traps appear to sample the run without bias.

SUMMARY

1. A method is needed for estimating the escapement of red salmon in turbid, glacial waters. Since it is impossible to count fish visually under such conditions by the usual means, such as towers or weirs, test-fishing techniques combined with mark and recovery experiments were adopted.

2. The objectives of the studies were to evaluate the traps, to obtain daily and annual indices of the size of the escapement, to determine rates of movement and spawning ground destinations, and to identify characteristics of the spawning migration.

3. Two traps were fished at the same locations for 3 years to provide a comparison of the size of the escapements annually. Other traps were fished at various locations to provide information about the variability in catch between trapping locations and to study the migration habits of red salmon in the river.

4. Fyke traps used in these studies were patterned after similar traps used in California and Oregon. They are 18 feet long and 10 feet in diameter, with provision for removing the fish through access doors. The traps were placed in fishing position by rolling them into the water at a suitable sloping site and were retrieved by means of a wire cable and hand winch.

5. Fish were removed twice each day, and samples were taken of the catch to provide age, length, and sex ratio information. Each year fish were tagged and released for subsequent recovery on the spawning grounds.

6. Gill nets were test fished in the river in the vicinity of the fyke traps to obtain another measure of the seasonal abundance and age, size, and sex composition.

7. Sufficient numbers of red salmon were taken to provide an index of the escapement each year. From July 1 to August 10, 1,726 red salmon were taken in the traps in the year 1957, whereas during the same period, 1,724 and 1,309 were captured in 1958 and 1959 respectively.

8. Fyke traps were fished in an array across the river to learn if the migration paths and behavior of salmon in turbid glacial water was similar to that in clear streams.

The tests showed that most red salmon travel upstream close to the bank of the river.

9. Diurnal movements of red salmon were observed during the studies and, as expected, trap catches revealed that the fish were moving chiefly during daylight hours. Significant numbers of red salmon were taken at night, however.

10. The migration of red salmon in Cook Inlet extends over a 3-month period. Comparisons of peak catches in the drift and set net fisheries and at the test-fishing site suggest that individual fish move through the fishery and upstream slowly. Tag recoveries showed that red salmon moved about 65 miles upriver in 20 days.

11. Changes in the size and age and sex compositions during the migration are attributed in part to the removal of large fish by the intensive commercial gill net fishery.

12. Red salmon taken in the traps were predominantly of age group 5_2 in 1957 and 1958 (they were 5 years old and had spent 2 years in fresh water and 3 years in the sea). In 1959 the dominant age group was 5_3.

13. Several findings show that fyke traps caught red salmon in relation to their abundance in the river: (a) In respect to timing, duration, and magnitude of the runs, catches in fyke traps were comparable to catches by the Cook Inlet commercial fishery; (b) catches were similar in the fyke traps that were fished in different locations; and (c) catches from test gill nets agreed in estimates of quantity and in age and size composition with catches from fyke traps.

14. The commercial catch by a set gill net fishery operating in the vicinity of the Kenai River mouth was compared with experimental fyke trap catches.

15. Samples of the run obtained by seining suggest that the fyke traps did not fish selectively for particular sizes of red salmon.

16. The conclusion drawn from these studies can be summarized as follows: (a) There is good evidence that the fyke traps catch red salmon in proportion to the strength of the spawning run, therefore, the trap catches can be used as an index of the escapement. (b) The escapement of red salmon in the Kenai River was considerably lower in 1959 than in 1957 and 1958. (c) Test-fishing with fyke traps is a reliable method for determining the size and age composition and sex ratio of the spawning migration in turbid, glacial waters.

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